Eighth Grade Science Overview

	First Semester	Second Semester
Science	Controlled experiments Periodic table of the elements Mixtures and compounds Force vectors Mass, weight, and gravity Laws of motion Types of energy Student-led scientific inquiry	Properties of waves Electromagnetic spectrum Reflection, absorption, and refraction of light Electric charge and electrical current Mesuring and controlling electricity Magnetism and electromagnetism Mechanical advantage Principles of aerodynamics Student-led scientific inquiry

Grade 8

Physical Science

Teacher Manual

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Introduction

This teacher manual is designed to help you support your students as they explore the field of physical science. This course was designed around Next Generation Science Standards (NGSS) and provides many opportunities for students to experience, explain, diagram, model, and reflect on the concepts they are learning.

While some of the assignments require specific answers, which are included here, others are more open-ended and require a different type of assessment. We have included suggestions for guiding your students and assessing their work, including what to look for in a student response and how to address misunderstandings.

Above all, learning should be viewed as a process. Incorrect answers and disorganized work provide an opportunity for the student to learn and develop skills. Approach the task of reviewing and assessing work as a way to guide and shape your student's learning experience. Whenever possible, express interest in what your student is studying and show an interest in the work your student produces. Watch relevant videos together. Observe or participate in experiments. Use the assignments as a springboard for discussions. Ask questions and listen to your student's response. These simple actions will result in a richer learning experience for both you and your student.

Lesson

1

Measurements and Quantitative Data

Learning Objectives

At the end of this lesson you will be able to:

- Demonstrate objective observations.
- Differentiate between subjective, objective, qualitative, and quantitative observations.
- Identify the basic components of a scientific argument.

Reading

Read the following sections (found in Reading Selections at the end of this lesson).

- The Flow of Discovery
- Scientific Inquiry
- Measurements and Quantitative Data
- Scientific Argument

Before you begin reading, glance over the length of the reading selections in this week's lesson. This is a good habit to get into—at the beginning of each lesson, scan all the work ahead of you. If you find a lot of reading material in a lesson, try to read one or two sections and then take a break before reading more. That way, you are more likely to remember what you read rather than if you had rushed through it.

In addition to the reading selections in this coursebook, you are encouraged to learn more about topics you are interested in by visiting the library, reading newspapers and scientific journals, and doing research online. You'll find a list of online resources at www.oakmeadow.com/curriculum-links. You can use these links to learn more about lesson topics.

ASSIGNMENT SUMMARY

- [ ] Complete the reading selections.
- [ ] Reflect on how knowledge is built on the work of others.
- [ ] Identify objective and subjective observations.
- [ ] Record qualitative and quantitative observations.
- [ ] Measure and describe household objects.
- [ ] Optional Activity: Scientists and Scientific Discoveries
- [ ] Complete lesson 1 test.

While you may not have time to read the material in each lesson, you can encourage your student to discuss the reading. This lets you get a sense of how well the information has been absorbed. Feel free to ask questions to prompt a discussion or request an expanded explanation.

Many students benefit from help with time management, especially at the beginning of a course. You might want to sit down with your student at the beginning of the week to look over the lesson material and make a plan for breaking the tasks into smaller sections spread out over the week. A student planner can be used to clarify what needs to be done and check off things that have been completed.

Assignments

At the beginning of each lesson, read the assignments, lab investigations, and activities to see what you'll be doing that week. Yes, this will take a little time, but it will help you get a good sense of how long things will take so you can manage your time better. You have a full week to complete each lesson, so there's no rush.

1. Think of a time when you have built on the knowledge of someone who came before you, and consciously taken it to the next step. Was this next step an improvement or a better design? Perhaps an activity you do is now more efficient. Write about one or two of your experiences.

   Answers will vary. Hopefully, students will be able to articulate an experience of taking information or a skill learned from someone else and changing it to better suit the purpose at hand. If your student has trouble thinking of an example, you might relate one from your own life.

2. Identify which of the following observations are objective and which are subjective.

Statement	Objective	Subjective
The cat is 20 inches long.	✓	
Its tail is striped orange and white.	✓	
It is friendly.		✓
The cat is fat.		✓
It weighs 20 pounds.	✓	
Its whiskers are white.	✓	
The fur on its paws is orange.	✓	
It enjoys lying in the sun.		✓

3. Practice careful and objective observation. Choose something to observe, either outdoors or indoors. Consider what you might need to do for the observation to be repeatable. If you're observing your dog playing in your backyard, you need to record the dog's actions as well as the time of day, the weather, the sounds around you, who else is there, etc. All these things are important and helpful information. For example, if you don't note that a thunderstorm comes up, and you just say, "The dog suddenly stopped chasing the stick and hid under a bush," we're not getting the full picture. You will need to use all your senses and record your data carefully and thoroughly. Be sure to be objective. Instead of saying, "My dog kept jumping up happily," you should say, "My dog jumped two feet off the ground six times in ten seconds while wagging his tail." That way the reader decides if the dog seems happy or not. Use clear and precise language when describing your observations. Make sure to include both qualitative and quantitative data.

   The observations should be clearly written with specific detail. Quantitative observations will include numbers—these are generally easy for students to record objectively. Qualitative observations are more challenging to form without judgement or bias. If necessary, ask questions to point out subjective observations and help students reframe them as objective statements. For instance, if the student writes, "The first bird aggressively attacked the second bird and chased it away," you might ask, "What makes the first bird appear aggressive?" After discussing the specific behavior that was observed, the statement might be rewritten to say, "The first bird flew directly toward the second bird at high speed, and the second bird abruptly changed direction and flew out of the area."

4. Find five objects in your house that are rectangular or square. The objects should be different sizes. At least one should be smaller than your hand, and at least one should be larger than a chair (such as an appliance). Take careful measurements using a metric ruler or tape measure and complete the table below. After measuring the item (quantitative data), write down one objective qualitative observation.

   The student will fill in the table in the coursebook. Check that the measurements include unit labels (centimeters, inches, etc.). Note the language used in the qualitative observation to make sure it is objective, and that another observer would agree with the statement, regardless of opinion. Qualitative observations might include the type of material (such as wood, iron, or plastic), color, texture, density, or appearance.

Activities

All the activities in this course are optional. Although these activities are not required, you are encouraged to choose any that interest you to help you gain a better understanding of the course material.

Activity: Scientists and Scientific Discoveries

The activities in this course are optional. Students are encouraged to choose those that interest them. See the coursebook for the full description of each activity.

Test

Answer the following questions using the knowledge you have gained in this lesson. Use correct terminology and refer to scientific concepts to support your answer whenever possible.

1. Explain the difference between an objective observation and a subjective observation.

   An objective observation is one that all observers would agree on, regardless of personal opinions or perspective. A subjective observation is based on a person's individual viewpoint, feelings, beliefs, or opinion.

2. Give three examples of quantitative observations.

   Examples will vary, and may include statements like the following:

   The tree is 30 feet tall and has leaves approximately 4 inches long.

   The ball is approximately 35 centimeters in diameter. When dropped from a height of 2 meters, it bounced approximately 1.5 meters high.

3. Give three examples of qualitative observations.

   Examples will vary, and may include statements like the following:

   The beavers' lodge appears as a rounded mound above the water.

   The fawn was light brown with white spots, and stood close to the hindquarters of the doe.

4. List and define the steps of a scientific argument.

   As explained in the reading, a scientific argument includes a claim, evidence, and reasoning. (This is a basic explanation of a complex process.) The claim is a conclusion or inference based on data, showing a relationship between factors. Evidence is the data that indicates the relationship. Often evidence is presented in a compiled form, such as a graph or table. Reasoning is used to explain how the data shows the relationship or supports the conclusion. If students struggle to understand how data might be used to support a claim, you might look for examples in recent news. For instance, you might find data that indicates a connection between the amount of sleep and academic performance, or data on rising sea levels and shrinking ice sheets, or on shrinking ice sheets and rising temperatures.

Learning Checklist

This learning checklist can be filled out by either you or the adult who is supervising your work. This checklist will help you keep track of how your skills are progressing and what you need to work on. You or your home teacher can also add notes about where you'd like help.

Here is what the different headings mean:

Developing: You still need to work on this skill.

Consistent: You use this skill correctly most of the time.

Competent: You show mastery of this skill.

Please remember that these skills continue to develop over time so you aren't expected to be able to do all of them yet. The main goal is to be aware of which skills you need to focus on.

SKILLS	Developing	Consistent	Competent	Notes
Differentiate between subjective and objective observations				
Define quantitative and qualitative data				
Record accurate measurements				
Use scientific terminology in explanations				

Lesson 2

Controlled Experiments and the Scientific Method

Learning Objectives

At the end of this lesson you will be able to:

- Identify the variable factors in an experiment.
- Design an experiment that controls all variables but one.
- Write a conclusion based on experiment results.
- Differentiate between causation and correlation.

ASSIGNMENT SUMMARY

- ☐ Complete the reading selections.
- ☐ Make a list of variables and how they can be controlled.
- ☐ Lab Investigation: Sink or Float?
- ☐ Complete lesson 2 test.

Reading

Read the following sections (found in Reading Selections at the end of this lesson).

- Scientific Method
- Variable and Constant Factors
- Controlled versus Uncontrolled Environments
- Using the Scientific Method
- Causation and Correlation

Look over the amount of reading before you begin, and make a plan to divide it up so you aren't trying to absorb too much information at once. If you have any questions about the reading, ask for help or do some extra research on your own.

It's important that your student has a clear understanding of the reading material. If possible, discuss the reading sections together, or ask for examples of the concepts.

Assignments

Before you begin your assignments, read through them to get a sense of what you'll be doing and how long it will take. This will help you manage your time better.

Take some time to make an observation around your home. Perhaps you notice that your cat naps in different places at different times of day. Or maybe you see that the temperature on one side of your house generally feels colder than on the other. Then make a list of variable factors that you might consider if you were to design an experiment. After each variable you list, explain how you might control that variable to make it a constant in your experiment.

Some students may need help determining an observation to use for this exercise. Feel free to give some ideas if more examples are needed. Possibilities may include houseplants that thrive in one place in the house but not another, where snack foods are stored and how often snacking occurs or what is eaten, or the preferred paths of passing from room to room for people or pets. Check that the list of variables is reasonably complete, and point out additional factors that may influence the behavior or phenomenon being observed. Each variable should be able to be controlled in some way. For instance, some controlled variables might include time, temperature, light, and movement. The goal is that each variable is present to the same degree each time the experiment is performed.

Lab Investigation

Complete the following lab investigation.

- **Lab Investigation: Sink or Float?**

All lab investigations are found in the physical science lab manual. Read the instructions carefully and assemble all your materials before you begin. Use good scientific habits by taking careful observations and measurements, recording your data in an organized way, and using precise, detailed language.

Lab investigations provide students with an opportunity to develop scientific skills and practice the scientific method. Look for students to follow the procedure with care, take accurate measurements, and record their observations in an organized manner. Summaries and conclusions should include the use of scientific terminology and concepts. See the lab manual for the full description of each lab investigation.

Lab Investigation: Sink or Float?

We all know light things float and heavy things sink. But some heavy things, such as ships, also float. How does the shape of an object influence its ability to sink or float? Your job is to design an experiment that tries to answer this question.

Procedure

The procedure of each lab investigation is only included in the teacher manual if there are specific tips about supporting your student or what to look for in the student response. Often steps will be left out if they are not relevant to the teacher manual. Check the lab manual for the full procedure and the student's responses.

1. Write your hypothesis. This is written as a statement about what you think will happen when you test how the shape of an object influences its buoyancy. Remember, your hypothesis must be testable and written clearly to indicate which variable you will be testing.

   This is a challenging assignment, and your student may need help with the different steps. Check that the hypothesis is clearly written and focuses on what will be tested. It should be written as a statement that gives a possible (likely) answer to the question, "How does the shape of an object influence its ability to sink or float?" Here is a sample hypothesis for this investigation: "Objects that are hollow or concave will float and objects that are flat or solid will sink." Check that the hypothesis is testable. If it is not, help your student revise it so that it is concise and focuses on one element as the variable.

2. Consider the variable factors that might influence whether an object floats or sinks. List as many factors as you can.

   Answers will vary. Lists may include what an object is made of, how much it weighs, its shape, whether it is dense or porous, and whether it is solid or has holes in it. Remember, this material may be new to students and they may need help generating a list of variables that influence an object's ability to float. Having a discussion and asking questions can help your student start to see the possible influencing factors.

3. In this experiment, your variable factor is the shape of the object. How will you control all the other factors? For each factor listed above, write down how you will keep it constant during the experiment. Include exact details about the value of the constant. The first one is done for you.

   See the lab manual; check the student's ideas for how to control variables.

4. Now you need to decide on five or more shapes that you will test. For instance, you might first test whether the ball of clay will float as is (in a ball shape). Then you might test it as a flat pancake shape, a round bowl shape, a boat shape, or any other shape. You might even test a shape with one or more holes in it! The more shapes you try, the more data you will collect. Write down a general description of the shapes you will test.

   See the lab manual for student response. If the shapes seem too similar, you may want to suggest adding a more unusual shape.

5. Now you will design your experiment, making sure to control all factors except the shape of the object. Explain in detail how you will conduct the experiment. Be as precise as you can. How much water will you use? What will the water temperature be? (Remember, it has to be held constant.) How long will you let each shape sit in the water? Will you drop the shape from above or carefully lower it into the water? (You have to do it the same way each time to get really accurate data.) Clearly state the variables involved and how you will control all the variables except for the shape of the object. Write down the procedure you will follow, step by step.

   Is the procedure written clearly enough for anyone to follow the same exact steps? If not, ask questions to get your student to clarify what information is missing. Make sure this information gets added to the procedure.

6. Perform the experiment, and record your results by writing down what you observe when you put each shape into the water. You can use the data table below or write your observations in list form. Use descriptive details to record exactly what happened.

   Check that the data has been recorded with accuracy and descriptive details.

Conclusions

1. Based on the results of your experiment, form a conclusion. Was your hypothesis correct? How does your data prove (or disprove) it?

   Answers will vary. Students should directly cite their data in their response.

2. List any questions that arise from your results. What else might you test to help shed more light on this question? Are there other variables you might want to test that may affect whether an object floats or sinks?

   Hopefully, students will come up with other variables to test or questions to ask. If not, you might model this scientific inquiry skill by asking questions that expand on the experiment or its results. For instance, would objects made of other materials, such as wood or plastic, act the same way if they were in the same shapes as the clay objects? Would the results of the experiment differ if a denser liquid, such as oil or laundry detergent, was used instead of water?

3. Do you feel your experiment was successful? Why or why not? If you were to do it again, how might you do it differently?

   Your student might want to redesign the experiment after trying it. That's great! Make sure your student rewrites the procedure so that it reflects the final experiment. The conclusion should directly refer to the results of the experiment, and include notes about how the experiment might be improved or redesigned for clearer results.

Test

Answer the following questions using scientific terminology. Refer to scientific concepts to support your answer whenever possible.

1. In your own words, explain the steps of the scientific method.

   The steps of the scientific method are as follows:

   <u>Question:</u> The problem or question is usually the result of an observation a person makes about something they have noticed that they do not know the explanation for.

   <u>Hypothesis:</u> The hypothesis is an educated guess as to the reason or answer for the observed behavior or question.

   <u>Procedure:</u> The procedure describes how the experiment will be conducted step by step.

Results: The observed results form the data collected from performing the experiment.

Conclusion: A conclusion is the interpretation of what the results indicate, including what may have influenced the results.

2. What is the difference between a variable and a constant? How many variables are normally in a scientific experiment? How many constants? Why are both part of every experiment? Give an example of each.

   A variable is an element that is changeable, and a constant is an element that is stable. In every experiment, a scientist will attempt to control and make stable all influential factors except one, which is the variable factor. There is usually only one variable while there may be many factors that are controlled or constants. Only by controlling all factors but one can the results of the experiment provide reliable data about the influence of the variable factor. For instance, in a plant growth experiment, the amount of sunlight, type of soil, and temperature might be held constant while the amount of water is varied.

3. Define *controlled environment* and give an example.

   A controlled environment is the space and circumstances under which an experiment is conducted where all the elements but one are controlled and identical. A laboratory is an example of a controlled environment because a scientist can set and control the light, temperature, air flow, and other factors that may influence the outcome of an experiment.

4. What does the phrase "correlation does not imply causation" mean? Make sure to define *correlation* and *causation* in your answer.

   Correlation refers to a relationship between two events, which may be incidental, and causation indicates a proven cause-and-effect relationship where one event always leads to another (*A* always causes *B*). Many events are correlated even though they do not directly influence one another or have many factors influencing them.

Learning Checklist

Use this learning checklist to keep track of how your skills are progressing. Include notes about what you need to work on. Please remember that these skills continue to develop over time.

SKILLS	Developing	Consistent	Competent	Notes
Describe the steps of the scientific method				
Write a concise, testable hypothesis				
Identify variable and constant factors				
Write a step-by-step procedure for an experiment				
Record data with accuracy				
Write a conclusion based on results				
Describe a controlled environment				
Differentiate between causation and correlation				

Lesson

6

Types of Mixtures

Learning Objectives

At the end of this lesson you will be able to:

- Demonstrate mixtures, solutions, and saturated solutions.
- Explain the variables that influence solubility.
- Differentiate between compounds and different types of mixtures.

Reading

Read the following sections (found in Reading Selections at the end of this lesson).

- Different Types of Solutions
- Solubility, Concentration, and Saturation
- Solutions, Colloids, and Suspensions
- Separating Mixtures

Assignments

1. Look for homogeneous and heterogeneous substances in your refrigerator or food cupboard. Make a list of what you find.

   Answers will vary depending on the food on hand. Homogeneous substances have a uniform appearance, and include such items as mayonnaise, broth, molasses, soy sauce, plain yogurt, and clear juice. Heterogeneous substances are varied in appearance, with individual

ASSIGNMENT SUMMARY

- ☐ Complete the reading selections.
- ☐ Identify homogeneous and heterogeneous substances.
- ☐ Create a graphic showing different types of matter.
- ☐ List soluble and insoluble substances.
- ☐ Answer questions about temperature and solubility of gases.
- ☐ Identify compounds and mixtures.
- ☐ Lab Investigation: Chocolate Solution
- ☐ Lab Investigation: Mixtures and Solutions
- ☐ Lab Investigation: Saturation of Sugar Solution
- ☐ Optional Activities:

  Activity A: Soda Shake

  Activity B: Oil Marble

  Activity C: Ocean in a Bottle
- ☐ Complete lesson 6 test.

elements visible, and include such items as chicken soup, chili, chunky tomato sauce, yogurt with fruit, macaroni and cheese, and refried beans.

2. Create a graphic or visual representation to show how matter is either an element, a compound, or a mixture. Also on your graphic, show that a mixture can be either a solution, colloid, or suspension. You might draw a concept map or Venn diagram to show this information (look up what these are if you aren't familiar with them).

   Students are free to create any type of graphic organizer. It should clearly show that elements, compounds, and mixtures are all matter, and that there are three different types of mixtures (solution, colloid, and suspension).

3. List three soluble substances and three insoluble substances.

   Answers will vary. Examples of soluble substances are sugar, salt, vinegar, and soap. Examples of insoluble things include coffee, tea, rocks, and a cat. This asks for things that dissolve (or don't) in water, so there may be some very creative answers.

4. Thermal pollution is caused when warm water is released into rivers from power plants and factories, raising the temperature of the river in that location and far downstream. All aquatic life depends on the oxygen that is in solution in the water (known as *dissolved oxygen*). What happens to the dissolved oxygen level if the water is warmed up, and how would this affect the aquatic life?

   Since gases dissolve better in cooler water, that means that cooler water can hold more oxygen. When the water in the ocean warms, it holds less dissolved oxygen. This means that there is less of this gas available to support aquatic plants and animals, and many are likely to sicken and die.

   Some students may wonder how dissolved oxygen gets into water. Anything that moves the water, like rain, wind, or currents, will increase the presence of oxygen in the water. That's why trout love cold running water, because both the cold and the churning of the water incorporate oxygen. Also, plants add oxygen to the water, as well as phytoplankton, which actually provide a third of the oxygen we breathe.

5. Indicate if the following items are compounds or mixtures, and for the mixtures, indicate which type.

Item	**Compound**	**Mixtures (solution, colloid, or suspension?)**
air		**solution**
seltzer water		**solution**
mayonnaise		**colloid**
salt	**yes**	—
salad dressing		**suspension**
bronze		**solution**
baking soda	**yes**	—
sweetened iced tea		**solution**
vegetable soup		**suspension**
whipped cream		**colloid**
strawberry ice cream (with real strawberries throughout)		**suspension (the ice cream is a colloid with the strawberries suspended in it)**
mud		**suspension**
iron oxide (rust)	**yes**	—
butter		**colloid**

Lab Investigation

Complete all three of the following lab investigations.

- **Lab Investigation: Chocolate Solution**
- **Lab Investigation: Mixtures and Solutions**
- **Lab Investigation: Saturation of Sugar Solution**

All lab investigations are found in the lab manual.

Lab Investigation: Chocolate Solution

This investigation might test your willpower as you experiment with dissolving candy in your mouth. Read all the instructions before you begin.

Conclusions

1. In your experiment, what was the solvent and what was the solute?

   The saliva was the solvent and the chocolate or candy was the solute.

2. Based on your results, what conclusions can you draw about the variables that affect how fast a solute dissolves? Explain your answer, using the terms *particle size*, *solution*, *solute*, *solvent*, and *dissolve*.

   Students should note that moving the candy around in their mouth caused it to dissolve more quickly than just letting it sit on the tongue, and breaking it into smaller particles with their teeth caused it to dissolve the fastest.

Lab Investigation: Mixtures and Solutions

This two-part lab looks at the difference between liquid solutions and mixtures.

Procedure: Part I

Check that the data table is filled out completely and accurately.

Conclusions

For each of the eight jars:

- Describe what you mixed
- State whether the result was a solution or a mixture, and explain your answer
- For solutions, identify which substance was the solvent and which was the solute
- For mixtures, state whether the mixture is miscible or immiscible

Jar 1 ingredients: water and vinegar

Solution

Solvent: water

Solute: vinegar

Jar 2 ingredients: water and rubbing alcohol

Solution

Solvent: water

Solute: rubbing alcohol

Jar 3 ingredients: water and powdered laundry soap

Solution

Solvent: water

Solute: powdered laundry soap

Jar 4 ingredients: water and liquid soap

Solution

Solvent: water

Solute: liquid soap

Jar 5 ingredients: water and flour

Mixture

Immiscible

Jar 6 ingredients: water and chalk

Mixture

Immiscible

Jar 7 ingredients: water and dirt

Mixture

Immiscible

Jar 8 ingredients: vinegar and oil

Mixture

Immiscible

Procedure: Part II

1. Choose one of your mixtures (not a solution) from part I. Think of a way to separate the substances. Write down your hypothesis (how you think you can separate the substances).

   One possible way to separate the substances is to allow the particles to settle, and then either drain off the liquid or allow it to evaporate. Other separation techniques include filtration and strong rotational or centrifugal force.

2. Perform your experiment (try to separate the substances). Record your results.

   Students should clearly describe what happened. If the results aren't clearly explained, ask questions to help the student identify where more description is needed.

3. How well did your separation technique work? Can you think of a better way to perform the separation?

   Answers will vary. Your student's response may provide a good starting point for a discussion about the lesson material.

Lab Investigation: Saturation of Sugar Solution

What is the balance of solvent to solute needed to reach the saturation point in a sugar solution? How does temperature affect saturation? This lab looks at these questions. Read all the instructions before beginning the lab.

Conclusions

Check the student's line graph. The water temperature should appear at the bottom with units of measure (degrees C or degrees F) clearly marked. Three data points should appear on the graph directly above the labels "Cold," "Warm," and "Hot." The three data points should be connected with a line, and the line is expected to rise from left to right, with the right side (the data for the hot water) to be the highest point of the graph. If the graph is unclear or shows something different, ask your student to explain what the graph shows.

1. Compare the three solutions. Do they have the same appearance? If not, how do they differ?

   Students will probably note that the hot water solution looks more cloudy as it has a higher salinity content than either the warm or cold solution.

2. Based on your results, what conclusions can you draw about how temperature affects the solubility of a solute? Did it take longer to get the sugar to dissolve in the cold water? How great was the difference in the amount of sugar that dissolved in the hot water versus the warm water, or the warm water versus the cold water? Write a conclusion, explaining what you observed. Cite your specific quantitative data in your explanation. Use the following terms in your conclusion: *temperature*, *solubility*, *solution*, *solute*, *solvent*, *dissolve*, and *saturated solution*.

   Observations should be written in clear, objective language, using correct terminology. There should be a marked difference in the amount of sugar in the hot-water solution compared to the cold-water solution, with the hot water holding more sugar before reaching its saturation point. Students will probably note that the sugar dissolved more quickly in the hot water.

   The conclusion should explain the scientific concepts behind the lab results and cite the quantitative data (the amount of sugar added to reach saturation point in each water temperature). Liquid solutions that are warm or hot can dissolve more of the solute than solvents that are cool or cold. The solubility of a solid—the amount of a solute that can be dissolved in a solvent—generally goes up with the temperature of the solvent.

   If something sounds confusing, ask your student to clarify. This will help you see if the student has grasped the concepts behind the lab.

Activities

Complete one or more of the following optional activities to learn more about the topics in this lesson.

- Activity A: Soda Shake
- Activity B: Oil Marble
- Activity C: Ocean in a Bottle

See the student coursebook for complete descriptions of the activities. Activities do not need to be graded in order for them to be beneficial to the student.

Test

1. List the three types of mixtures and explain the similarities and differences between them.

   The three types of mixtures are solutions, colloids, and suspensions. The size of the particles determines what type of mixture it is. In a solution, the particles are broken down or dissolved by the solvent into the size of molecules, and the molecules are evenly mixed together so that the substance is homogeneous. In a colloid, a substance is broken down into microscopic particles so it can mix well with another substance, but the particles are insoluble, so they won't dissolve but instead remain suspended. In a suspension, you can easily see particles of the components floating around and the substance is heterogeneous, not homogeneous. If the suspension is allowed to rest, the particles will either float to the top or sink to the bottom.

2. Define solute and solvent.

   The solute is the substance that is dissolved, and the solvent is the substance that acts to break down or dissolve the solute.

3. Give an example of a homogeneous mixture and a heterogeneous mixture, and explain the difference between them.

   Answers will vary. See assignment #1 for definitions and examples.

4. What are immiscible liquids? How do they differ from miscible liquids? Give an example of each.

   Immiscible liquids are those that do not dissolve when mixed together; miscible liquids dissolve when mixed together. Vinegar and water are miscible liquids because they dissolve to form a solution when mixed together. Vinegar and oil are immiscible liquids because they do not dissolve into a solution when mixed together. Student examples will vary.

5. Explain how temperature influences the solubility of gases in liquids.

   The solubility of a gas in liquid increases as the temperature of the liquid goes down. This means that more gas is held in a dissolved state in a cool liquid than in a warm liquid.

Learning Checklist

Use this learning checklist to track how your skills are developing over time and identify skills that need more work.

SKILLS	Developing	Consistent	Competent	Notes
Identify similarities and differences between types of mixtures				
Differentiate between homogeneous and heterogeneous substances				
Differentiate between miscible and immiscible liquids				
Use scientific terminology in writing lab results and conclusions				
Record observations with accuracy and clear language				

Lesson 17/18

Scientific Inquiry: Energy in Food Systems

Lesson Objectives

- Design an original project related to energy use in food systems.
- Create a scientifically accurate informational graphic.
- Reflect on project design and learning experience.

For your final assignment in the first semester of this course, you will design a project based on an area of interest related to food. The goal of this lesson is to give you an opportunity to explore how energy is used in the production of food. You will look at how energy changes forms during the food production process, where energy escapes in an unusable form, and how this energy loss can be minimized or recaptured for practical use.

Refer to the lab manual for full instructions.

- **Scientific Inquiry: Energy in Food Systems**

You will have two weeks to complete this project. The instructions in the lab manual will give you a framework to help you organize your time.

If you haven't yet worked with someone else on a project, consider collaborating with one or more partners. This will allow you to experiment with new ways of working, and to generate a design that is based on multiple perspectives. (If you are enrolled in Oak Meadow School, your Oak Meadow teacher can help you find a partner.)

ASSIGNMENT SUMMARY

- ☐ Research an element of energy use in food production.
- ☐ Design a project to convey your findings.
- ☐ Discuss the project with others to refine the design.
- ☐ Create a scientifically accurate graphic related to energy use in food production.
- ☐ Share the project with others.
- ☐ Reflect on project design and learning experience.
- ☐ Complete semester 1 review.

After you have completed your project, complete the self-assessment found in the lab manual.

See the lab manual for the full description of the project and the learning reflection. Most students will benefit greatly from careful guidance from an adult during each stage of the process, particularly in the early stages of brainstorming and project planning. Refer to the student's learning reflection from lesson 4 to identify ways to provide support for this project.

This project is large in scope yet your expectations of student work can be modest. This is a rich, complex topic that warrants an entire year-long course of study. The goal of this

project is to have students begin to gain an awareness of food systems and how energy travels through them, how energy is used, wasted, and can be conserved. If the student's work shows understanding of even one small part of this topic, the goal has been satisfied.

Students are encouraged to share their work. For students who chose to share work online, you may want to help them create parameters, especially for those who are sensitive or not very experienced with social media. For instance, if a video is posted on YouTube, you and your student might agree that it will have the comments disabled, and the student will check the number of views only once a day, or once a week. You can help your student keep things in perspective by noting that even if just a few people view the video, it may have really benefited one or two, and that's a meaningful accomplishment.

Semester 1 Review

The following review gives an overview of the topics you have studied in the first semester. Read each question and then ask yourself if you fully understand the concept and could answer the question orally without looking at the book. Alternately, you might like to have someone ask you each question and answer it aloud, or you may prefer to write down your answers. Make a note of any questions you can't answer, and take some time to go back and review the material to refresh your memory.

Semester 1 Review

1. What did both Galileo and Copernicus propose about the universe?

   They both proposed that the sun was the center of the universe. This is called the heliocentric theory, and Copernicus came up with it first. Galileo did further observations, and agreed with Copernicus. (Lesson 1)

2. How many centimeters are there in a kilometer?

   Since there are 100 centimeters in a meter, and 1,000 meters in a kilometer, that means there are 100,000 centimeters in a kilometer. (Lesson 1)

3. What is the difference between a milliliter and a cubic centimeter?

   There is no difference. They are the same volume. (Lesson 1)

4. Describe the steps of the scientific method.

   Question: Identify a problem or question by observing the situation.

   Hypothesis: Make an educated guess about the situation, as a possible answer to the question.

   Experimental procedure: Test the hypothesis by isolating a single factor and controlling as many other factors as possible.

   Results: Carefully and accurately record the results of the experiment.

Conclusion: Use the results to look for patterns and cause-and-effect relationships in order to state whether or not the hypothesis was correct, and to reveal if further testing is needed. (Lesson 2)

5. What is the difference between weight and mass?

   Weight is the force of gravity on an object, and mass is the amount of matter in an object. (Lesson 3)

6. If you take a cup of water vapor, and put it into a 2-cup container, what happens to the pressure?

   Water vapor is a gas and gases expand to fill the container they are in. With twice the volume and the same amount of water vapor (same number of molecules), the pressure will decrease by half. (Lesson 3)

7. What is the difference between a mixture, a compound, and a solution?

   A mixture occurs when different substances are combined, but they each retain their own unique properties, and can be separated by physical means. A compound occurs when substances are chemically combined to form a new substance, which has different properties from any of the original substances. A compound cannot be separated except chemically. A solution is a type of homogeneous mixture where one substance dissolves in another. (Lessons 5 and 6)

8. Describe the three ways that heat is transferred.

   Conduction is heat transfer through and between substances that are adjacent to each other, and is caused by molecules vibrating back and forth. Convection occurs only in fluids, and is caused by molecules moving in a circular pattern. Radiation is heat traveling by way of electromagnetic waves called infrared waves. It is given off by things that contain heat, and doesn't need a medium to travel through. (Lesson 7)

9. Give an example each of the following types of forces: applied force, normal force, action-at-a-distance force.

   Answers will vary. An applied force is a type of contact force where something is pushing on something else (for instance, hammering a nail). A normal force occurs when something is supporting something else to hold it in position (for instance, a wall holding you up when you lean against it). An action-at-a-distance force occurs when the objects are not in physical contact, but still exert a force (for instance, gravity). (Lesson 8)

10. What is your weight in kilograms (kg)?

    The student's weight should be multiplied by the conversion factor 0.45 kg per pound. (Lesson 9)

11. Explain Newton's First Law of Motion.

    Also known as the law of inertia, this law states that an object at rest will tend to remain at rest, and an object in motion will tend to keep moving at the same speed and in the same direction unless an unbalanced force acts on it. (Lesson 10)

12. What is the difference between velocity and acceleration?

    Velocity is the speed and direction of a moving object. Acceleration is a change in velocity; it can be an increase in speed, a decrease in speed, or a change of direction. (Lesson 11)

13. What is Newton's Third Law? Describe an example.

    Newton's Third Law states that for every action, there is an equal and opposite reaction. Examples include a ball bouncing off a wall and a seat belt that exerts pressure when a person is pushed against it. (Lesson 11)

14. List four types of energy.

    Different types of energy include electrical, light, heat (thermal), sound, mechanical, gravitational, and chemical energy. (Lesson 13)

15. What are the two laws of thermodynamics?

    The First Law of Thermodynamics (also known as the Law of Conservation of Energy) states that energy cannot be created or destroyed; it can only change form. The Second Law of Thermodynamics states that whenever energy changes form, some is converted to heat energy and released. (Lesson 14)

16. What is work? What is power?

    Work is the application of force to an object that causes the object to move; work is a transfer of energy and is calculated as force times distance. Power is the rate at which work is done, and is calculated as work divided by time. (Lesson 15)

17. What is a turbine?

    A turbine is any kind of a machine that spins to generate power. Turbines are used in most forms of electric generation. (Lesson 16)

18. After learning about all these different forms of energy, if you could build your dream home, what type(s) of energy would you use in it?

    Answers will vary and may include one or more renewable sources of energy. (Lesson 16)

Lesson

23

Sight and Lenses

Learning Objectives

At the end of this lesson you will be able to:

- Illustrate light refraction through convex and concave lenses.
- Demonstrate the correlation between focal length and distance from object to lens.
- Explain the difference between a converging and a diverging lens.

Reading

Read the following sections (found in Reading Selections at the end of this lesson).

- Lenses
- Converging and Diverging Light Rays
- Creating Images with the Eye
- How Do Eyeglasses Work?
- How a Camera "Sees"

You might find the videos included on the curriculum resource page very useful in understanding these concepts.

Assignments

1. Take a shiny soup spoon and look at your reflection in the side that holds soup. What does it look like? Now turn the spoon over and look at your reflection in the back of it. What does it look like now? Describe what you observed, using the terms *concave* and *convex*.

ASSIGNMENT SUMMARY

- ☐ Complete the reading selections.
- ☐ Explain the difference between convex and concave shapes.
- ☐ Identify and draw one type of lens.
- ☐ Complete demonstrations regarding perspective and focus.
- ☐ Demonstrate and explain depth perception.
- ☐ Describe observations of double image.
- ☐ Lab Investigation: Image Projection
- ☐ Optional Activities:

  Activity A: Anatomy of the Eye

  Activity B: Focusing a Light Beam
- ☐ Complete lesson 23 test.

Students are asked only to describe their observations without explaining why these phenomena occur. The reflection from the concave surface of the spoon will be upside down. This has to do with the angles of reflection off of the curved surfaces. The convex back of the spoon will show a right side up reflection. Because of the convex curves, the reflection may look distorted, similar to how funhouse mirrors work, widening some parts of the image.

2. Find in your house (or among your friends) either a pair of glasses or a magnifying glass. Examine it closely. What kind of lens is it? Draw a sketch of it and name the type of lens.

   A magnifying glass uses a converging lens, and is probably a double convex lens. The eyeglasses of a person who is nearsighted will use a diverging (concave) lens. The eyeglasses of a person who is farsighted will use a converging (convex) lens.

3. Complete the following exercises.

   a. Stand and look at a small object (for example, a candle, a small bowl, or a knot on a tree). Keep looking at the object and place your hand over one eye. Observe whether the object stayed in the same place or moved. Look at the object again with both eyes. Now put your hand on the other eye. What happened? Which eye kept the image in the same place? Which eye made the object move? (The eye that kept it in the same place is your dominant eye.)

      This simple exercise shows which eye is dominant. Most people, even those with very good eyesight, will see some difference. Those wearing corrective lenses will probably not see any difference unless they remove the lenses.

   b. Hold the first two fingers of each hand horizontally, touching tip to tip four to six inches away from your eyes. Focus your eyes on something in the distance beyond your fingertips. Keeping your focus in the distance, slowly separate the fingertips about a half inch. What do you see "floating" between your fingertips?

      The student should see a sausage-like object "floating" between the fingertips. The image is the two tips of the fingers appearing to be fused together. It is due to the eyes being focused on an object farther away, with the result that the nearer images double, one image for each eye. The two images overlap, producing the sausage-like image. Students are not asked to explain it, but only to describe their experience.

4. Put a piece of paper on a table in front of you and make a dot on it with a pencil. Touch the dot with the tip of the pencil with both eyes open. Then cover one eye with your hand and try touch the dot with the tip of the pencil again. Explain what happens, using the term *depth perception*.

   The student will probably experience difficulty in trying to touch a small point with a pencil when they can only see with one eye. Students should note that this is because one needs both eyes to have perspective or depth perception.

5. Fill a clear, smooth, round jar with water. Stand a pencil vertically about a foot behind it on a table (use some modeling clay or beeswax to hold it up). Now look at the pencil through the jar. How many pencils do you see? What happens to its size? Now close one eye. Which pencil disappears? Close the other eye. Which pencil disappears? Taking into account the convex shape of the glass, why do you think this is happening? (It's okay if you aren't sure—just try to explain it based on what you know.)

   The student will probably notice that when looking through the jar of water with both eyes, two pencils are seen. When one eye is closed, only one pencil appears. Students are asked to apply their knowledge of refraction and lenses to try to explain what is happening—they may or may not be able to. If not, share with them the reason, which is related to the curvature of the jar. This creates a convex lens image. Each eye sees the pencil from a different angle, creating two separate images. When the student closes one eye or the other, there is only one image of a pencil; the image that particular eye is seeing.

Lab Investigation

Complete the following lab investigation (found in the lab manual).

- **Lab Investigation: Image Projection**

Lab Investigation: Image Projection

This lab explores the relationship between the image projection and the distance of an object from a convex lens.

Conclusions

Do you see a pattern between the distance of the object in front of the lens and the size of the projected image? What is the relationship between these factors? Describe this correlation.

The distance between the object and the front of the lens is correlated to the size of the projected image. If the object is more than twice the focal length in front of the lens, the image projected beyond the focal length will appear smaller and inverted (upside down and backward). As the object is moved closer to the front of the lens, the image will appear larger, and still inverted. When the object is placed at a distance of twice the focal length, the object and the inverted image will appear the same size. When the object is moved closer to the front of the lens, at a distance of less than twice the focal length, the object will appear magnified and inverted.

Check the student's response against the data collected to make sure the correlation is backed up by the data.

Activities

These activities are optional.

- Activity A: Anatomy of the Eye
- Activity B: Focusing a Light Beam

See the coursebook for full descriptions of these activities. Note: Adult supervision is required for Activity B: Focusing a Light Beam.

Test

1. Draw a picture of a convex and a concave lens, and use arrows to show what happens to light waves when they hit each type of lens. Be sure to label your drawing to clarify what it shows.

   See the coursebook for images of convex and concave lenses. The light is refracted toward the normal line by a convex lens, causing the light to converge on a focal point. The light is refracted away from the normal line by a concave lens, causing the light to diverge and spread. Check that the drawing is clearly labeled. The arrows indicating the direction of light waves should match those in the coursebook.

2. What is the difference between the focal point and the focal length?

   The focal point is where an image is most in focus. The focal length is the distance between the lens and the focal point.

3. What is the difference between a converging lens and a diverging lens?

   A converging lens is a convex lens, which refracts light waves inward and toward one another until they converge at the focal point. A diverging lens is a concave lens, which refracts light waves outward and away from one another.

4. What type of lens is in the eyeball?

   The eye's lens is a convex lens.

Learning Checklist

Use this learning checklist to track how your skills are developing over time and identify skills that need more work.

SKILLS	Developing	Consistent	Competent	Notes
Differentiate between concave and convex lenses				
Illustrate refraction of light through a convex lens				
Illustrate refraction of light through a concave lens				
Explain the difference between a converging lens and a diverging lens				
Identify correlation between focal length and distance from object to lens				